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- Plated steel sheet having two plating layers and excellent in antifriction, corrosion resistance and painting adaptability.
- A plated steel street having two palling layers and excellent in antification, corrusion resistance and peinting enlargiability, which comprises: a steel sheet; a zinc plaining layer formed on at least one surface of the sensitient and excelorablent player formed or the zinc plaining layer. The zinc plating layer has a plating weight of from 25 to 150 g/m² per surface of the steel sheet. The electroplating layer comprises at least one electred selected from the group consisting of chromaten, transganess, inch. cobalt and incled, and the electroplating layer tax as plating weight of from the 105 g/m² per surface of the steel sheet.

REFERENCE TO PATENTS, APPLICATIONS AND PUBLICATIONS PERTINENT TO THE INVENTION

As far as we know, there is available the following prior and document pertinent to the present invention: "Plating & Surface Finishing", March 1989, pp. 62-69.

The contents of the prior art disclosed in the above-mentioned prior art document will be discussed bereafter under the heading of the "BACKGROUND OF THE INVENTION".

FIELD OF THE INVENTION

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The present invention relates to a plated steel sheet having two plating layers and excellent in amilifiction upon present priming, correspon resistance and calming adaptability.

BACKGROUND OF THE INVENTION

it is general, the body of an automobilie is exposed to a certosive environment, and particularly to a severe convolve environment in a coestial area or a cold area where an automobile tends to come into contact with a substance conflaining chlorine ione having a violent correctivity.

A zinc plated steel sheet or a zinc alloy plated steel steel is conventionally widely used as a steel sheet for an automobile body having an excellent corrosion resistance even in such a severe corrosive an ampliforment

The conventional zinc plated steel sheet has however the following problems:

(1) The zinc plating layer of the zinc platind steel sheet, having a relatively low herdness, is detormed upon the press-forming of the zinc plated steel sheet, trus increasing a contact rare between the zinc plating layer and the pressing portion of a press in other words, the zinc plated steel sheet has a frictional coefficient higher than that of the other steels sheets such as a cold-rolled steel sheet or a zinc also plated steel. Where the zinc plated steel sheet, therefore, cracks may be

produced in the zinc plating layer thereof. As is clear from the above description, the conventional zinc plated steel sheet is poor in antifriction floreination referred to as the "problem 1"; and (2) When applying an electropariting to the zinc plated steel sheet to bring film on the surface thereof, the high throtogen overvollage of the zinc plating layer causes the opn-uniform production of a

hydrogen gas during the electropainting, and the thus non-uniformly produced hydrogen gas which is confined in the panifing film causes craters in the painting tilm, thus resulting in a poorer cratering resistance of the zinc plated sleei sheriff thereinatter reterred to as the "proplem 2").

It is a conventional practice, as a means for solving the problem 1, to apply a high-viscosity lubricant oil so onto the surface of the zino plated steel sheet prior to press-forming same to improve antifriction of the zino bland studies thatet.

Application of the high-viscosity subricant oil onto the surface of the zinc plated steel sheet as described above poses however the following problems:

(a) The high-viscosity lubricant oil contaminates the working place; and

(b) it is necessary to remove the high-viscosity lutricant of applied onto the audisce of the zinc plated steel sheef prior to applying painting thereto. This removing operation is not however easy. Complete removal of the high-viscosity furthers of invasives much time and labor.

With regard to the frictional coefficient of a zinc electroplated steel sheet, the "Plating & Surface Piramino", March 1989, pp. 62-69 leaches as follows thereinable referred to as the "prior art"):

6) Application of a conventional anticorrosive oil onto the surface of the zinc electroplating layer having crystate oriented along the (0001) plane, leads to a relatively large initional coefficient thereof of 0.19; and

(ii) Application of a conventional anticonosive oil onto the surface of the zine electroplating layer having crystals oriented along the (10TX) plane (where, X is 1, 2, 3 or 4), on the other hand, essuits in a small inclinant confitient thereof of 0.13.

Apart from the above-mentioned problems resulting from the application of the high-veccety wholeant of, the bine deletopated sets of sheet applied with the high-vescety subvision of on the surface thereof has a small frictional coefficient of 0.11. If the orientation of the crystate of the zinc electropating layer atong the 10TD plane (where, X is 1, 2, 3 or 4) as taugiff by the prior at can be maintained, an antificiation of the seme order as in the application of the high-vescety historian of the world would be available by the application of the convectional anticorrestve oil which is easy to remove, onto the surface of the zinc electroplated steel sheet.

However, the crystal orientation of the zinc electroplating tayer of the zinc electroplated steel sheet

depends upon electroplating conditions, and among offers, upon an electric current density. As a result, it is inevitable to alon the plating conditions in response to the width, for example, of the steel sheet to be electroplated, in the manufacture of the airc electroplated stank sheet in an industriat scale, if it practically impossible to maintain the orientation of the crystals of the zinc electroplating layer along the (101X) plane hybric, vis et al. 2, 3 or 4).

A means to solve the problem 2 has not as vet been proposed.

Under such circumstances, there is a strong demand for the development of a plaied steel sheet so the adjustment of a plaied steel sheet has not say yet been proposed.

SUMMARY OF THE INVENTION

An object of the present invention is therefore to provide a plated steel sheet having two electroplating layers and excellent in antifriction, correction resistance and painting adaptability.

In accordance with one of the features of the present invention, there is provided a plated steel sheet laving two plating layers and excellent in antifriction, corrosion resistance and painting adaptability, characterized by comprising:

a steel sheet:

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a zinc plating layer formed on at least one surface of said steel sheet, said zinc plating layer having a zo plating weight within a range of from 25 to 150 orm⁵ per surface of said steel sheet, and

an electroplating layer formed on sext zinc plating layer, said electroplating layer comprising at least not element selected feom the group consisting of chromium, manganese, icon, postalt and nickin, and said electroplating layer having a plating weight writtin a range of from 1 to 10 g/m² per surface of said steel shorts.

SRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a graph illustrating, for the plated steel sheet of the present invention, which has a zinc plating layer as a lower layer formed on the surface of the steel sheet and an electroplating layer as an upper layer formed on the zinc plating layer, the relationship between a frictional coefficient of the plated seen sheet and a plating weight of the electroplating layer as the upper layer; and

Fig. 2 is a schematic front view illustrating an apparatus for measuring a frictional coefficient.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

From the above-mentioned point of view, extensive studies were carried out to develop a plated steel sheet having two plating layers and excellent in antifriction, corrosion resistance and painting adaptability.

As a result, the following lindings were obtained: A planed steel sheel having two plating layers and excellent in antifiction, corrosion resistance and painting so adaptability is evaliable by the following steps:

(1) forming a zinc plating layer on at least one surface of a sheel sheet;

(2) limiting a plating weight of the zinc plating layer within a range of from 25 to 150 g/m² per surface of the steel sheet;

(3) forming an electroplating layer comprising at least one element selected from the group consisting of chromium, manganese, iron, cobell and nickel, on the zinc plating layer; and

(4) limiting a plating weight of the electroplating layer within a range of from 1 to 10 g/m² per surface of the steet sheet.

The present invention was made on the base of the above-mentioned findings. The plated steel sheet of the present invention having two plating layers and excellent in antificition, corrusion resistance and to plating stapitality is described below with reference to the drawings.

The platest steel sheet of the present invention excellent is writhriction, correspon resistance and painting adaptability comprises a steel sheet, a zinc plating layer as a lower layer formed on at least one surface of the steel sheet and an eteroropialing layer as an upper layer formed on the zinc plating layer.

The zinc plating layer as the forms layer formed on at least one surface of the steel sheel has a function so of imparting an excellent corresion resistance to the plated steel sheet.

The zino platting tayer is formed by either of the electroplatting method and the dip-platting mothod, with an enew widely diffused as an industrialized processes. When forming the zino platting layer by the electroplatting method, a zino electroplatting bath is selected from among a bath compating wallsta, a bath

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containing chloride and a bath containing a modure of cullate and chloride. When forming the znic plating layer by the dis-plating method, any one of the commonly utilized zinc dis-plating baths is used.

The plating weight of the zinc plating layer as the fower layer earns an important effect on corrosion resistance, artification and operat-formability of the plated seed sheet. With a plating weight of the zinc opining layer of index 25 g/m² per surface of the steel sheet, a cheired corresion resistance recursors for a sust-provenitive steel sheet used as a material for an automobile body is not extendible. With a plating weight of the zinc plating layer of over 150 g/m² per surface of the steel sheet, on the other hand, when forming same by the electroplating method, sinc crystate of the zinc electroplating layer becomes coarsor. As a result, a critical method of the zinc electroplating layer as the same plating is an extension of the zinc electroplating layer as the upper layer. In addition, with a plating height of the zinc plating layer of over 150 g/m² ger aurface of the cleek sheet, when forming the zinc plating layer by the 6th-plating method, a zinc deposition in the width direction of the plating sheet plating height of the zinc plating layer as the lower of layer plating layer as the cleek sheet, when forming the zinc plating weight of the zinc plating layer as the lower of layer plating layer as the cleek sheet sheet sheet sheet of the zinc plating layer as the lower of layer plating the plating the plating weight of the zinc plating layer as the lower.

The electroplating layer as the upper layer, which is formed on the zinc plating layer as the lower layer and comprises at least one element selected from the group consisting of chromium, managenes, iron, cobalt and nickel, has a function of imparting an excellent painting adaptability as typically represented by a high cratering resistance and an excellent artifiction. Since all the above-mentioned elements have a high realthing resistance and an excellent artifiction. Since all the above-mentioned elements have a high religious that the craterian state of the paper layer of the view and plating layer of these elements as the upper layer is therefore formed by the electroplating meltiod. The electroplating emitted with the use of an electroplating ball such as a bath containing cuttant, a bath containing chloride, a bath containing a mixture of sutfate and chloride, or a bath containing brondlaytide.

76. It is a graph fliststating, for the plated steet sheet of the present invention, which has a xinc plating layer as a lower layer formed on the surface of the steet feeter and an electroplating layer as an upper layer formed on the xinc plating layer, the relationship between a incitional coefficient of the plated steel sheet and a plating verify of the deschoplating layer as the upper layer. More perficularly, a zinc descripting layer as a lower layer having p plating verying if 60 girlly on surface of a test sheet sheet was formed only the selectoplating method on one surface of the test sheet. Then, a minist elicotoplating layer as an upper layer was formed on the circleptating algory by the electroplating method while changing the plating weight of the nucket electroplating layer. A finitional coefficient was measured for the plated sheet sheet having the time formed two obtains layers.

As is clear from Fig. 1, when the plating weight of the nickel electroplating layer as the upper layer is under 1 g/m² por surface of the steel sheet, the plated sleel sheet has a high frictional coefficient. When the plating weight of the nickel electroplating layer as the upper layer is over 10 g/m² par surface of the steel sheet, on the other hand, the plated seel sheet has a constant finctional coefficient at a level of up to 0.1, which does not discrease to believe the level. This applies, not only to the case where the above-mentioned nickel electroplating layer is formed as the upper layer, but also to the case where an electroplating layer or comprising a least one element selected from the group consisting of chromium, manganese, iron, coball and circle is formed as the coper layer.

When the plating weight of the electroplating layer as the upport layer is under 1 pm² per surface of the steel sheet, the frictional coefficient of the plated siled sheet is high as described above, so that entilinicities of the plated steels sheet is detericated. When the plating weight of the descriptishing layer as the upper 4s layer is over 10 gm² per surface of the siled sheet, on the other hand, the frictional coefficient of the plated stoel direct becomes constant at a level of to is 0.5.

As a resulf, not only the effect of the electroplating layer of improving antiferition of the plated sheet is saturated, but also connosion resistance of the plated sheet sheet becomes poorer. The plating weight of the electroplating layer as the upper layer, which comprises all least one element schedul from the group or consisting of chromium, manageness, iron, coball and nickel, should therefore be limited within a range of from 1 to 10 m² for surface of the should show that the characteristic state.

As described above, an excellent artificition is impatted to the platest steet sheet, by forming the obscriptibing layer as the upper layer, which has a pitating weight within a range of from 1 to 10 gard per surface of the steet sheet and comprises at thisse one element selected from the group consisting of accidination, managanese, from, noball and nickel, on the zime plating layer as the lower layer. The reason of this is estimated to be as follows:

The zinc plating layer of the zinc plated steel sheet has a relatively low hardness. Therefore, the zinc plating layer having a low hardness is deformed upon the press-forming of the zinc plated steel sheet. As a

result, a contact area between the zinc plating layer and the gressing portion of a press bucomes larger, leading to a higher fribitional coefficient of the zinc plated steel sheet. Antifriction of the zinc plated steel sheet therefore bacomes forms. On the other hand, both a cock-rolled steel sheet and a zinc alloy plating layer of a zinc alloy plated steel sheet have a high hardness.

5. When the odd-rathed steel sheet or the zinc alloy dated steel sheet is preservamed, therefore, the surface of the odd-rathed steel sheet or the zinc alloy plating layer are hard to deform. As a result, a small contact area between the surface of the cod-rathed steel sheet or the zinc plating layer and the pressing portion of the press leads to a low fictional coefficient. The cold-voited steel sheet or the zinc alloy plated steel sheet is forefore oxcellent in analyticion. The above description suggests that a higher fractness of the surface of a steel sheet provides a many excellent arthritten of the feels sheet.

In the present invention, the electroplating layer as the upper layer has a remarkably higher horderses then that of the zinc plating layer as the lower layer. When the plated steel effect of the present invention is presidenteed, benefits the zinc plating layer as the lower layer deforms because of the low herdness thereoft, and the electroplating layer as the toper layer is hard to deform because of the high herdness traction. As a result, a small confact area between the surface of the electroplating layer and the presump portion of the press leads to a low inclinional coefficient of the plated steel sheet. The plated steel sheet of the pressure invention is therefore excellent in a multicular.

More particularly, when the plating weight of the electroplating layer as the upper layer is under 1 g/m² per surface of the steel sheef, most part of the surface of the zinc pleting tayer as the lower layer is 20 exposed, and the contact area between the electroplated steel sheet and the pressing portion of the press becomes larger. The results in a high frictional coefficient of the plated steel sheet as in the above-merriforand rine plated steel sheet. According are the plating veight of the electroplating layer as the upper layer more sufficiently covered the zinc plating layer as the lower layer. These electroplating layer as the upper layer more sufficiently covered the zinc politicity layer. This results in a smaller contact area between the plated steel sheet and the preceding portion of the press. As a result, the frictional coefficient of the plated steel sheet and the preceding portion of the press. As a result, the frictional coefficient of the plated steel sheet and the preceding portion of the press. As a result, the frictional coefficient at a low level, which no longer discreases form this level.

b In addition, the electrociating layer as the upper layer, which comprises at least one element selected from the group consisting of chromium, menganese, iron, cubelt and nicket, imports an excellent painting adaptability, i.e., an excellent cratering resistance to the plated steet sheet.

More specifically, a hydrogen gas, if produced non-uniformly when forming a painting film by the electropainting on the surface of the stated sheet, is confined in the painting film, thus misuteng in the second process of craters in the painting film.

However, since the electropialing layer as the upper tayer of the plated steel sheet of the present invention, which comprises at least one element selected from the group consisting of chromium, rangangue, ron, cobetin and ricket, files a two hydrogen coverablege, a tydroging pas is uniformly produced when forming a painting film by the electropainting. This results in a vary rare occurrence of craters in the opiniting film, thus leading to an excellent painting adaptability, i.e., an excellent cratering resistance of the citaed steel sheet.

Now, the plated steel sheet of the present invention having the two plating layers and excellent in antificition, corrosion resistance and painting adaptatility, is described further in detail by means of examples white comparing with examples of comparison.

EXAMPLES

as.

Each of cold-rolled stead sheets having a thickness of 0.7 mm was subjected to a conventioned degreesing treatment and a conventional pickling treatment are remove that from the total surfaces thereof. Then, the detel sheet from the both surfaces of which rust was thus removed, was subjected to an electroplating under the conditions shown in Table 1 to form a zinc electroplating layer as a lower layer on each of the both surfaces of the steet sheet, in preadle with the above-mentioned electroplating, each of another cold-rolled diesel sheets having a truckness of 0.7 mm, from the both surfaces of which not was removed by the same method as discribed above, was subjected to a dip-plating under the following so conditions to form a zinc dip-plating stoyr as a lower layer on each of the both surfaces of the steel sheet.

- (b) Plating equipment: Continuous zinc dis-plating equipment having an annealing facility in the tine.
- (c) Plating bath: Zinc dip-plating bath containing aluminum in an amount of 0.14 wt.%,

- (d) Plating bath temperature: 460°C,
- (c) Annealing temperature : 850 °C,

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The plating weight was controlled by the gas equeezing method.

Then, each of the sieel sheets having the zinc electroplating layer or the zinc dip-plating layer formed or resch of the both surfaces thereof, was subjected to manifer electroplating under another conflictions shown also in Table 1 to form an electroplating layer as an upper layer, which comprised at least one elements selected from the group consisting of chronitini, manganese, from, cribet and nickel, on the zinc electroplating layer or the zinc dip-balling layer. Thus, samples of the electroplating layer or the zinc dip-balling layer. Thus, samples of the electroplating steed show which has scope of the present invention (hereinafter referred to as the "campiles of the invention") Nos. 1 to 54 were to preciared.

For each of the samples of the treention Nos. 1 to 54, the plating weight per surface of the steel sheet of the zinc electroplating layer or the zinc dip-plating layer, elements and the contents thereof of the electroplating layer, and the plating weight per surface of the essel sheet of the electroplating layer are shown also in Table 1.

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For comparation purposes, each of steel sheets idealical with those in the samples of the leveration Rics.

I to 54 (except for Noc. 37 and 38), was subjected to a conventional degreesing treatment and a conventional picking breatment for remove rush from the both surfaces five-red. Then, the steel detect from the both surfaces of which next was thus removed, was subjected to an electroplating under the conditional shown in Table 2 to form a currended place as a lower layer on each of the both surfaces of the

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stopi sheet.

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Then, each of this steel sheets heaving the zinc dischoplating layor formed on each of the both surfaces thereofs, was subjected to another elichoplating under another constituent shown also in Table 2 to form an electroplating layor as an upper layor on the zinc electroplating layor. This samples of the electroplated is steril sheet outside this scope of the present invention thereinable referred to as the "teamples for comparison") Nos. 1 to 7 were prepared. Each of the samples for comparison Nos. 1 to 7 were prepared. Each of the samples for comparison Nos. 1 to 7 were prepared. Each of the samples for comparison Nos. 1 to 7 were prepared. Each of the samples for comparison Nos. 1 to 7 were prepared. Each of the samples for comparison Nos. 1 to 7 were prepared. Each of the samples for comparison Nos. 1 to 7 were prepared.

The plating weight per surface of the steel sheet of the êtic electroplating tayer as the lower layer for each of the samples for comparison Nos. 1 to 7, as well as ubeneats and the contents thereof of the electroplating layer as the upper layer, and the plating weight per surface of the steel sheet of the above-mentioned electroplating layer for each of the semples for comparison Nos. 2 to 6 are also shown in Table 2.

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Flactum conditions for forming simp electroplating layer	Composition of planting wath	63,769	≱ogS*n	9	-		3	*	*	i.
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Than, for each of the thus prepared samples of the invention Nos. 1 to 54 and the samples for comparison Nos. 1 to 7, antificition, corrector resistance and parting adoptability were investigated by means of performance tests as described below. The results of these tests are shown also in Tables 1 and 2.

(1) Antifraction test:

A mineral off type articocrosive oil for a steel sharls (product name, NOX RUST \$30F40) manufactured by Parker Industries, Inc. was applied one one surface of each of the samples of the avvention Nos. 1 to 54 and it is samples for comparison Nos. 1 to 6, and a high-viscosity lutricast oil (product name: FERRODOTE 51-MAL-HOL-1) manufactured by highon Gusker Chemical Co., Ltd. was applied onto one surface of the sample for comparison No. 7. The frictional coefficient of each sample on one surface of which the anticocrosive oil was applied and the frictional coefficient of the sample for comparison No. 7 on one surface of which the high-viscosity lutricant was applied, were measured with the use of an apparatus as shown in 10 Fig. 2, three-by evaluation antificition of each sample on the base of the trus measured (fictional coefficient).

The apparatus for measuring frictional coefficient of the sample complised, as shown in Fig. 2, a reals 2; a supporting stant 5, provided or the reals 2 vertically moveably along a purality of quide root 12 and 13; attached vertically to the reals 2, and having a purality of robust 6 in the tupor end offered a supporting stant 5 and favoring the supporting stant 5, a first load only provided between the supporting stant 6 and the reals 2, the measuring the force applied vertically to the supporting stand 5 a pressing block 4 filled to a framm 3 fiscal to the rack 2 so as to project toward the supporting stand 5 and five pressing block 4; a stilling lable of rounded on the rollers 6 of the supporting stand 5 and the pressing block 4; a stilling lable driving mechanism (not shown), provided on another reals 11, for horizontally movely eligible glable 7, and a second total cell 8, provided between an operating rod 10 connected to the stilling table from postations and one and of the stilling lable? The research stands are real stilling lable 7, and a second total cell 8, provided to the reals are reasonable to the reals and the reals of the supporting stand 5 and the pressing block 4; a stilling lable (in the reals).

By operating the supporting stand driving mechanism, the supporting stand 5 was moved upward to this up the stiding label 7 on the upper surface of which a sample 1 was placed. Thus the upper surface of the sample 1 was placed. Thus the upper surface of the sample 1 was preceding the sample 1 was preceding the sample 1 was preceding to the sample 2 with the sample 2 direction was measured by means of the first load cell 8. Then, by operating the stiding table driving mechanism, the eliding table 7 was principately moved in the arrow 8 direction, togother with the cample 1 placed on the upper surface thereof, and the force 8 applies in the arrow 8 direction to the stiding table 7 was measured by means of the second load cell 9, at the moment when the stiding table 7 was reduced the moving speed of 1 minimises. The ratio of the force 8 to the force 9 to the 9 to 10 to

(2) Cretering resistance feet:

Each of the samples having a width of 70 mm and a length of 150 mm was subjected to a dipping type as phosphating for a steel sheet for automobile in a phosphating solution (product name: PBL 3080) manufactured by hilling Perfecting Co., Ltd. to form a phosphating thm on this surface of the sample. Then, the sample was subjected to a cation type electropainting with the use of a paint (product name: ELECRON 8400) manufactured by Konsail Paint Co., Ltd. under the following conditions to form a painting film having a histories of 20 um on the phosphate film:

(a) Impressed voltage: 280 V,

- (b) Area ratio between anode and cathode: 1:1.
 - (c) Electrification: instantameous one.
 - (d) Electrifying time. 3 minutes.

Cratering resistance was evaluated by means of the number of craters produced in the painting film as dusting the formation of the painting film as described above. The criteria for evaluation were as follows:

- A: up to ten cretere produced within a circle of a diameter of 40 mm at the center of the sample,
- Be from 11 to 190 such crafers,
- C. at least 101 such craters.

so (3) Corresion resistance fest:

Correction resistance was evaluated by means of perforation resistance and blistly resistance as follows:

(a) Perforation resistance:

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As in the cretering resistance test as described above, a phosphate film was formed on the dustane of each of the samples, and a painting film having a thickness of 20 km was formed on the phosphate film by means of the electropainting. Then, a noticit was provided in the thus formed painting film. Each of the part of the electropainting.

samples having the thus notiched painting film was time subjected to 60 cycles of corrosion tests, each cycle comprising a salt water spray, a drying, a dipping into salt water, and a drying for 24 hours. Then, the painting time, and corrosion products produced during the corrosion test, ware removed from each sample thus subjected to the 60 cycles of corrosion tests, and the maximum corrosion depth produced in the steel s where was resourced. Perforation resistance was evaluated by means of the thus measured maximum corrosion debt. The critical for evaluation were as follows:

- A: A maximum corresion depth of under 0.1 mm.
 - A maximum corresion deeth within a range of from 0.1 to under 0.2 mm.
- C: A meximum correction depth within a range of from 0.2 to under 0.4 mm, and
- in D: A maximum corrosion depth of at least 0.4 mm.

(b) Elister resistance:

As in the cratering resistance lest as described above, a phosphate film was formed on the surface of each of the samples, and a lower painting film having a thickness of 10 cm was formed on the phosphate film by means of the discrepainting. Then, a milling at thickness of 35 cm and an upper painting film having a thickness of 35 cm were formed on the titus formed lower positing film having a thickness of 35 cm were formed on the titus formed lower positing film. Then, a rother was provided on the titus formed tiple-layer positing film. More specifically, each sample was exposed to the open are for a peoid of on one year, during which sall water having a so them chickle content of 8 vt.% was sprayed over the sample at a rate of twice a week. Then, the macmum bister width of the painting film was measured on one side of this notion in the sample after the sait spray yeat, and bitter resistance was evaluated by meens of the thus measured maximum bister width of the painting film was measured on one side of this notion in the sample after the sait spray rest, and bitter resistance was evaluated by meens of the thus measured maximum bister width of the painting film.

- A: A majornum blister width of under 1 mm:
 - B: A maximum blister width within a range of from 1 mm to under 2 mm;
 - C: A maximum blister width within a range of from 2 mm to under 2.5 mm; and
 - D: A maximum blister width of at least 2.5 mm.

As is clear from Table 1, all the xamples of the invention Nos. 1 to 54 had a frictional coefficient of up to 0.16, and were therefore excellent in antifiction.

All the samples of the invention Nos. 1 to 54 were excellent in painting adaptability as typically represented by a high cratering insistance with the number of creates of up to 10 produced within a circle of a disenter of 40 mm at the context of the sample, as avalated by A.

In terms of perforation resistance and bitcher missilances, which represented correction resistances as although the samples of the invention Nos. 34 and 35 were slightly poor, all the other samples of the invention were excellent. Each of the samples of the invention Nos. 34 and 35 was slightly inferior in correction resistance to each of the samples of the invention Nos. 1 to 33 and 36 to 54 because the plating weight of the zinc electropising layer of each of the samples of the invention Nos. 1 to 33 and 36 to 54 and 35 was senation than that of each of the samples of the invention Nos. 1 to 33 and 36 to 54.

6 As is evident from the above description, all the samples of the invention Nos. 1 to 54 were excellent in antifection, corrosion resistance and cainting adaptability.

As is clear from Table 2, in contrast, none of the samples for comparison Nos. 1 to 7 satisfied simultaneously the following three favorable ments possessed by each of the samples of the invention Nos. 1 to 54:

- is (i) a frictional coefficient of up to 0.16 in the antifriction test;
 - (ii) a maximum blister width of under 2.5 mm and a maximum compsion depth of under 0.4 mm in the corresion test; and
 - (iii) a number of creters representing painting adaptability of up to 10 in the cratering resistance test.
- More garticularly, the sample for comparison No. 1 having the zinc electroplating styler as the single layer and applied with the anticorrosive oil for a sized sheet on the surface thereof had a large frictional custificient of 0.5. The sample for comparison No. 2 having a low plating weight of the circle electroplating layer as the opport layer outside the scope of the precent invention had a large frictional coefficient of 0.28. The sample for comparison No. 3 having a high plating weight of the circle discincipating layer as the spoper layer outside the scope of the present invention was pour in perforation presidence and bistor residence.
- or The sample by comparison No. 4 having the zino-iron alloy electroplating layer as the upper layer and the sample for comparison No. 5 having the zino-incise alloy electroplating layer as the upper layer, which were coulside the scope of the present invention in that the electroplating layer as the upper layer contained zinc, were poor in cratering resistance. The sample by comparison No. 6 texting a low plating weight of the zinc.

electropisting layer as the lower layer outside the scope of the present invention was poor in perforation resistance and blinner resistance.

Furthermore, a high-viscosily lubiricant oil (grodect name: FERRICOTE 61-MAL-HCL-1) manufactured by Nippon Custer Chemical Co., Ltd. was applied onto the zinc electroplating layer as the single layer of it has sample for comparison No. 7 applied with the Night-viscosity libiticant oil on the zinc electroplating layer thereof. The abover-remindened sample for comparison No. 7 applied with the Night-viscosity libiticant oil on the zinc electroplating layer thereof. The abover-remindened sample for comparison No. 7 bad a feltional coefficient of 0.11. This revealed that the samples of the invention Nos. 1 to 54 applied with the easily removable anticorrorive oil had substantially the earn's entitle of the sample for comparison No. 7 applied with the high-viscosity lubicant oil which was very difficult to ename.

According to the present invention, as described above in detail, it is possible to provide a plateif steel effects from the plateif series and painting layers and excellent in entifiction, conceilor resistance and painting adaptability, thus providing industrially useful effects.

re Claims

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- A pisted sheet having two plating layers and excellent in antifriction, corrosion resistance and osinting adaptability, characterized by comprising.
- zo a steel shoot;
 - a zinc pletting layer formed on at least one surface of said steet steet, said zinc pletting layer having a platting weight within a range of from 25 to 150 o/m² per surface of said steet sheet; and
 - an electroptating layer formed on said zinc pitaling layer, said electropitating layer comprising at teast one element selected from the group consisting of chromium, manganese, iron, cobalt and nickel, and said electroplating layer having a plating weight within a range of from 1 to 18 g/m² per surface of add steel shoet.
- A plated steel sheet as claimed in Claim 1, wherein: said zinc plating layer is an zinc sloctroplating layer.
 - A pleted steel sheet as claimed in Claim 1, wherein: said zinx; plating layer is a zinc fito-plating layer.
 - A plated sheel as claimed in any one of Claims 1 to 3, wherein: said electroplating layer comprises chromium.
 - A plated steel sheef as claimed in any one of Claims 1 to 3, wherein: said electropisting layer comprises manganese.
 - A pittled steel shoot as claimed in any one of Claims 1 to 3, wherein: said electropisting layer comprises iron.
- A pland sleet sheet as claimed in any one of Claims 1 to 3, wherein: eaid electroplating layer comprises cobalt.
 - A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: said electroplating layer comprises nicket.
 - A plaind steel steet as claimed in any one of Claims 1 to 3, wherein, said electroplating layer comprises from and cobalt.
 - A plated elect sheet as claimed in any one of Claims t to 3, wherein said electroplating layer comprises iron and nickei.
 - A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: said electroplating layer comprises iron and manganese

- A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: said electroplating layer comprises iron and chromium.
- A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: said electropisting layer comprises cobalt and nicket.
 - A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: said electroplating layer comprises cobalt and manganese.
- 10 15. A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: said electroplating layer comprises cobalt and chromium.
 - A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: said electropialing layer comprises sicket and manganese.
 - A plated steel sheet as claimed in any one of Claims 1 to 3, wherein, said electroplating layer comprises nicket and chromium.
- 18. A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: as eald electroplating layer comprises manganese and chromium
 - A plated sheet as claimed in any one of Claims 1 to 3, wherein: said electropiating layer comprises fron, cobalt and nickel.
- 20. A plated steel sheet as claimed in any one of Claims 1 to 3, wherein; said electroplating layer comprises iron, manganese and chromium.
 - A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: said atectroplating layer comprises iron, nickel and chromium.

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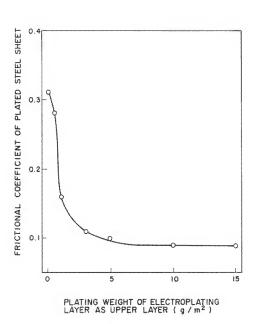
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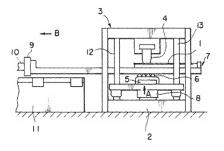
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 A plated steel sheet as claimed in any one of Claims 1 to 3, wherein: suid electropialing layer comprises nickel, manganese and chromium.

FIG.I



F | G. 2



EUROPEAN SEARCH REPORT

Application Number

EP 91 10 6540

Stations	Citation of document with indication of rejevent passages	t, ohere appropriette,	Relevant to cixim	CLASSIFICATION OF THE APPLICATION Sec. CL5)
×	PATENT MESTRACTS OF JAPAN vol. 8, no. 114 (C-225)(1551) & JP-A-59 025 992 (NAMASANI February 1984	26 May 1984 SETTETSU MX 10	1,2,15	C2505/18
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